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PAPERS

RELATING

TO THE SYSTEM OF PERIODICAL MEASUREMENTS

OF

IRRIGATED LANDS

AND

THE DISTRIBUTION AND ECONOMY OF WATER.

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CANAL REVENUE ESTABLISHMENTS.

Distribution and Economy of Water.

Minute by Judicial Commissioner, 14th April 1863; Memorandum by Financial Commissioner, 1st June 1863; Financial Commissioner's No. 2015, 4th June 1863.

NOTE by Secretary to Government Punjab, Public Works Department.

The first of these papers is the Minute prepared by Mr. Cust, after the meetings of the Committee appointed by His Honor the Lieutenant-Governor to inquire into the present system of periodical measurements of irrigated lands, and the means of remedying the evils attendant upon it.

2. This Minute and other papers belonging to the subject were afterwards forwarded to the Financial Commissioner. With the return of the papers he sent the Memorandum dated 1st June, and this was followed by the letter of 4th June, containing suggestions on the subject of the distribution and economy of water.

3. The question first started arose from a review of the canal-measuring establishments employed periodically in remeasuring the lands irrigated by the canals.

4. The Sudder Board of Revenue N. W. Provinces had some time ago raised the question of collection of canal revenue in those provinces by the ordinary revenue establishments, instead of, as at present, by special revenue establishments under the canal officers. The Financial Commissioner having addressed the Superintendent Western Jumna Canals on the subject, and requested his opinion of the probable reduction of expense by the adoption of this arrangement on those canals, received reply from Major Merrick that the reduction would be inconsiderable, as the establishments would still have to be retained for measurement of the irrigated areas, though relieved of the collection of the water revenue.

5. The whole Public Works establishments of the Punjab and N. W. Provinces were under review of Government of India, and their orders were awaited before doing anything further with regard to the question of these measuring establishments. The orders ultimately received did not embrace the Revenue establishments attached to the Public Works department. The question of these measuring establishments was then ordered by His Honor the Lieutenant-Governor to be taken up by a Committee which was appointed after His Honor's return to Lahore from Delhi (Mr. Cust, President).

6. Mr. Cust's minute expresses his views after the discussions held by the Committee.

7. The system of water rate levied according to amount of water discharged, instead of according to area of land irrigated, obviates the necessity for land-measuring establishments altogether, with the additional advantage of economising water. This system had been introduced on the Ganges Canal. It has been found to be attended with certain practical difficulties, due mainly to the quantity of silt carried by the waters of these canals, and to the variations of discharge by the same opening under the variable conditions of the main channel.

8. On this account the system has not been adhered to on the Ganges Canal. It has been found expedient to revert to the levying of water rate by area irrigated. The other has been retained in a few instances, when desired by the people using the water. But it is felt by the officers concerned to be practically untrustworthy.

9. The arrangement for regulating the volume of water discharged from the canal into the main distributing channels, as proposed for introduction on the Ganges Canal, is described in paragraphs 11, 12, and 13 of Colonel Baird Smith's letter, No. 168 A of 20th May 1854, to the Secretary to Government N. W. Provinces, printed with other papers on the subject by order of the Government. The practical difficulties and probable sources of error were foreseen, and are adverted to in paragraphs 7, 10, and 11 of that letter, and in paragraph 7 of the reply, Mr. Muir's No. 1454 A of 11th December 1854. But it was believed that the errors were capable of being reduced within such moderate limits that the

system might be accepted as, for practical purposes, correct. The errors and the uncertainty are found in practice, according to the experience of the system as hitherto worked on the Ganges Canal, to be of greater import than was anticipated. The introduction of reliable measurement of discharge is, for the reasons before mentioned, very desirable. At present this cannot be done. Till some mode is devised of overcoming the present practical difficulties, the basis of the water rate must continue to be irrigated area.

10. When the system of measurement of discharge was thus proposed to be adopted on the Ganges Canal, it was at the same time proposed that the system of water assessment should be ultimately a system of contracts for fixed periods, and that with a view to obtain the most reliable data for adjustment of the terms of such contracts and gradual improvement of the whole arrangements, a series of careful measurements should be made for some time of the areas irrigated in connection with the distribution of water by volume, and an officer should be specially appointed to superintend these measurements, and collect all the information required. The scale for the contracts, in the first instance, was to be fixed on the basis of the average results obtained on the Jumna Canals. But it was felt how imperfect was the knowledge derived from these for the purpose in view. And though, to begin with, a certain standard of irrigating work done by a given quantity of water had to be adopted (the standard was 300 beegas * per annum for each "paymana" of water (a defined theoretical discharge †), yet this was nothing more than a rough guide for a commencement. It was obvious that the ratio of the quantity of water to area irrigated is affected by local qualities of soil, as well as by the different requirements of different crops. And further, and more especially, that the area which any given quantity of water was made to irrigate, under a system of assessment according to irrigated area, which offered no inducement to economising of the water, was likely to be a fallacious measure of the work that would be done by a given quantity, under a system which made it the interest of every one using the water to make the most of it and allow no waste.

* Beega = 625 of an acre.

† One cubic foot per second.

11. The proposed careful measurement would supply the canal officers with the information required to determine the volumes of water to be issued, and to settle the water rate. The same information is required for apportionment of water rate according to the existing system. It is for this purpose that the present periodical remeasurements are made. The disadvantages of these repeated complete measurements were adverted to in connection with the proposals in 1855, for introducing the improved system of water measurement on the Jumna Canals, and "the larger use by the canal officers of the land revenue records of village areas, with the view of reducing the actual measurement work to a minimum," was one of the improvements proposed. (Colonel Baird Smith's No. 2568, dated 20th February 1855.)

12. When this point was discussed by the Lahore Committee, it was agreed that the existing land revenue records in Punjab do not afford sufficiently accurate data for employment for the purposes of irrigation assessment. And one principal reason for the remeasurement each season, namely, that the boundaries of fields are changed by the cultivators, is not met by the use of the land revenue records, unless they are kept corrected up to date with the minuteness required for canal assessment purposes. And this leads to the question, cannot this be done by the ordinary revenue establishments, so that their records shall at any time be correct up to date, and available for the purposes of the irrigation assessment?

13. It was believed by some of the members of the Committee that this could be done. But it was the President's conclusion, after full discussion of the question, that a separate measuring establishment is required, at least so long as the irrigation in question has not nearly reached its limits, and is extending yearly, as on the Baree Doab Canal.

14. Mr. Cust, with reference to the proposal that the Putwarees should be utilised for this purpose, states the objections. If the Putwarees kept the land measurement records correct up to date with the accuracy required for canal purposes, this would be an extra duty for which they would have to be paid. They have at present, as Mr. Cust observes, to test the village maps annually. For canal purposes this would be required twice a year.

15. Mr Cust's objection to the employment of the Putwarees for the required half-yearly statement of areas, instead of paying a special measuring establishment, is that the Putwarees could not do what is required without neglecting their proper duties. This would be a decisive reason against the arrangement. But the objection appears to be made on the supposition that the Putwarees' services would be placed at the disposal of the officers of the Canal department. This would certainly be objectionable. But it is not necessary, and this has not, it is believed, been contemplated by any of the officers who have advocated the employment of the land revenue records for canal assessment purposes, and the periodical correction of these land revenue records by the ordinary land revenue establishments. This would be done under the officers of their own department. Some of the civil officers of the Committee expressed a readiness to try in their own divisions or districts the system proposed to carry out the necessary correction of measurements up to date, as required for canal purposes, and to furnish the canal officers, in good time for each irrigation assessmemt, with the required detailed record of areas. If this could be carried out, the Canal department would still be required to make a few check measurements here and there in order to be satisfied of the general correctness of the measurements on which the work done by the canal was being exhibited and charged. It is proposed by Mr. Cust that this should be tried in two pergunnas.

16. There are still obvious advantages in keeping the agency for supplying the data for canal assessment, which must be ready by a certain time, independent of the possible requirements of another department. But the work required for the purposes of both is so closely the same, that it appears most desirable to save what must clearly be, in a great measure, superfluous—a direct repetition of work already done and recorded, and the record of which is available. The annual cost of the separate measuring establishment attached to the Canal department is large. And it has to be considered whether, supposing the land revenue establishments capable by any arrangement of furnishing the data required for canal purposes, the advantage gained by the employment of a separate establishment justifies the cost at which it is obtained.

17. Difficulty has been caused by Zemindars altering the boundaries of fields, also by their irrigating at times only part of certain fields. The alteration of boundaries and form of fields cannot be absolutely prohibited, but it might be required that this should not be done without notice, and penalties might be attached to the neglect of this rule. And with regard to partial irrigation of a field area, it might be ruled that no smaller division of land than the recorded fields would be recognised for irrigation purposes; that the irrigation assessment would be on the area of the field any part of which is irrigated. When this is known, arrangements would be made accordingly, and there would be no hardship or inconvenience.

18. The further difficulty stated by Mr. Cust, arising from the question, "did the crop have water, and sufficient water?" is one which may occur under any system of measurement, and is not necessarily connected with the question of the agency by which the measurements are made. The Canal department would still, in any case, have to record which fields are irrigated; but this does not require measurement. And the question of sufficiency of water is apart altogether from the question of measurement and record of areas.

19. Mr. Cust states his conclusions in the form of ten propositions. I. II. V. VI. belong to the general treatment of canal irrigated lands, and the proposals are in my opinion right. The other propositions relate to the question immediately under consideration, and should likewise be accepted; only X. I would put in the form above suggested, which is in accordance with Mr. McLeod's recommendation. VII. is the proposal for trial of the plan of obtaining the required field measurements from the Putwarees' records.

20. Mr. McLeod, in his memorandum on Mr. Cust's paper, concurs generally with Mr. Cust, but differs in a few important particulars.

21. Mr. McLeod remarks on the great importance of the arrangements for distribution of water, and observes that "if this duty were effectively and faithfully performed, the other duties of measuring and assessing would be altogether subsidiary, and the

charge on account of these might be reduced to a minimum," and that " if the several departments of work be systematised and placed on a really efficient footing," " both the cost and the harassment attending the half-yearly measurements will be reduced to something very inconsiderable."

22. Mr. McLeod does not explain in what manner the improvement of the arrangements for distribution of water would affect the arrangements for measurement of fields irrigated. With the most perfect system of distribution (except under the system before referred to of assessment by volume of water) the correct knowledge of the precise areas irrigated is still required. So long as irrigated area is the basis of the assessment, the most complete efficiency of the distribution arrangements cannot dispense with the accurate record of field areas; and it is to obtain this that the present half-yearly measurements are made.

23. Mr. McLeod strongly advocates (paragraph 9) the retention of the measurement for canal assessment in the hands of the canal officers, and dissents from Mr. Cust's proposal to give the other plan a trial in two pergunnas. The proposal, however, which he adds is in substance that which was advocated, which would dispense with the detail measurements by the Canal department, using the Land Revenue records for canal purposes; the necessary corrections up to date being made by the Land Revenue establishments, and these corrected data supplied to the Canal department, thus relieving that department of the costly measurements now under consideration, and requiring only the ordinary check measurements to test the correctness of the data. This, if it can be arranged, will in the fullest manner accomplish the object in view.

24. Mr. McLeod lastly seconds Mr. Cust's proposal for the entire separation of the Canal Revenue establishments, and their cost from Public Works schedules. This last is certainly right. This is not a charge which should belong to a Public Works Budget. But it has to be remembered that these special Revenue establishments do not represent the whole, and that the results shown by their separation and their charge to Revenue would not be completely correct. The Canal officers themselves, who are Public Works officers, are the principal members of the Canal Revenue establishments.

25. And with respect to the two classes of duties, there are some advantages in their being in the hands of the same establishment, who, in charge of all that relates to their respective sections of canal, can, along with the supervision of the distribution of water and land measurements, also execute all necessary repairs, and be responsible for the condition of the works. There are obvious disadvantages, besides the cost, in having separate subordinate establishments, on the same ground, in charge of operations so closely interdependent. But the cost can be distributed.

26. The question of combined assessment of the Land and Canal revenues has not entered into the present discussion. But it can hardly be kept altogether apart from the present questions connected with the relation between the Canal and Land Revenue departments. This combination of assessments is an arrangement which, at one time opposed by the late Colonel Baird Smith, was afterwards fully accepted by him and advocated. He says in 1851, "It might to a certain extent simplify accounts, and be a slight relief to the people in a single form, to consolidate the Land and Canal revenues, and to collect them by means of the civil establishment; but this arrangement is open to so many objections, and would produce so much embarrassment and difficulty in carrying on the duties of the canals, that its introduction would be followed by consequences far too injurious to the interests of the State and the people to be in any degree compensated for by the trifling benefits to be anticipated from it." (*Calcutta Review*, No. 23, and Appendix B, Report on Italian Irrigation, Vol. I. page 326). In 1861 he writes (Report on the Famine of 1860-61, paragraph 158, page 78), "I have already explained the manner in which the Canal and Land Revenue systems have become partially interwoven. The Settlement Officer, as a general rule, increases his assessment on estates watered from canals by reason of the increased assets which the command of canal water insures; and the proportion of increase may be taken on the average at about 25 per-cent of the Government demand. Now, I believe it will be found to simplify matters exceedingly if the identification of Land Revenue and Irrigation Demands, now made in a partial, be made hereafter in a perfect manner; and that for a mixed levy, part collected by the Collector,

and part by the Canal officer, there be substituted a single levy, collected exclusively by the Collector, but carefully discriminated in Record and Account, and credited duly to the Land Revenue and Irrigation departments in its proper proportions." The collection of Canal Revenue by the Civil establishments is now carried out on the Baree Doab Canal; but the Land Revenue and Irrigation Demands are not identified in the manner here proposed.

27. Mr. Cust adverts before the conclusion of his Minute to the system of contracts for water, and expresses regret that the system has been abandoned on the Western Jumna Canals. We should look to contracts, he observes, as our great object, whether we arrive at the data on which a contract can be based by a measurement of the water discharged through a regulated outlet, or by a consideration of the statistics of area irrigated for a long period of years.

28. Contract based on measurement of water discharged is comparatively simple. There is of course a possible disturbing element in the length and form of minor distributing channel along which the water flows between the regulated outlet where it is measured and the field where it is used; also in the nature of the soil in which the channel is dug, on the conditions of which depends the amount of loss after measurement.

29. Contract by area irrigated is affected by varying circumstances in the application of the water. One soil absorbs the water rapidly and consumes a large quantity; another is more retentive at the surface and consumes less. The fields are not used year by year for the same description of crop. One year there is a crop needing much water, another year a different crop needing little. But the contracts being for a term of years, and based on the experience of a series of years, would cover the inequalities of requirement of one year with another, and meet the case of special local conditions of soil.

30. But the point requiring to be taken into consideration in dealing with this subject of contracts based on experience of present practice, is that in the working of the existing system of assessment by area irrigated there is great waste of water and no inducement to economy. Experience has given the measure before mentioned of

average irrigation work done by a given quantity of water, but this is under the operation of a system in which it is known there is waste; and the uncertainty and probable incorrectness of this measure, as a a measure of irrigation work which *may* be done by a certain quantity of water, is generally acknowledged. We want, then, as a true basis for contracts a system which economises the water to the utmost, rather than the existing arrangement which offers no inducement to economy. This is what the system of charge by volume of water issued would furnish. An arrangement is required which, similarly encouraging economy under the present system of charge by irrigated area, shall furnish right data for contracts under this system. Mr. McLeod's letter No. 2015 of 4th June 1863, which is the third of the papers named at the head of this memorandum, proposes a plan by which, along with other important ends in view, this much-desired object might be effected.

31. Mr. McLeod's proposition is briefly this. At present the distribution channels are made, for the most part, to deliver the water on the surface of the ground, so that irrigation is effected by natural flow from openings in the banks of the channel. This method of water supply, which reduces the field labour to a minimum, is that which is most valued on this account, and most highly paid for. Land thus irrigated by water delivered on the surface is charged a high water rate. Land irrigated from channels carrying the water below the ground level, and from which the water has to be raised or thrown, is charged at a lower rate. But it is the easily-obtained water which is not economised. The same area of land, when the water has to be obtained by a certain amount of labour, can be served by a smaller total quantity of water; and (which is the important point) the same quantity of water can be made to irrigate a larger area. Mr. McLeod's proposition is that the distributing channels should carry the water altogether below the surface, so that it should not in any case be delivered on the fields by natural flow, but in all cases require to be raised.

32. By this arrangement the water would everywhere be economised. A certain amount of labour, however small, being required to obtain it, no more would be used than actually required, and the whole canal supply would go much further, that

is would irrigate a larger area of the whole country. Mr. McLeod has other objects in view in his proposition; in particular the waste which occurs at present, throwing large quantities of water abroad, unused, in the neighbourhood of villages, and which is a fruitful source of sickness, would cease. On this account it has lately been arranged that all the irrigation from the Baree Doab Canal, in the neighbourhood of Umritsur, should be from channels kept within soil.

33. That the arrangement proposed would by economy of water furnish more proper data for a system of contracts than the present arrangement is a point to be specially taken into consideration. It is very desirable that we should adopt data obtained from the most economical application of water as the basis of a system of contracts, which it should be our great aim to establish as soon as reliable data of this kind have been obtained. The great importance of fixity of demand on account of water for irrigation in place of fluctuating charge is set forth in Colonel Baird Smith's Report on the Famine of 1860-61 (paragraphs 154, 155, 166, &c.), and can scarcely be too strongly insisted on. Colonel Baird Smith's arguments on behalf of fixity of demand are applied to his proposal of a settlement of demand in perpetuity, under a system of measurement of water, and are equally applicable, with but little modification of the value of the results, to demands fixed for a term of years by contract under a system of charge by area irrigated with utmost economy of water.

34. Mr. McLeod (see paragraph 11 of his letter) referred to Captain Dyas for his opinion of the proposed measure—keeping the supply channels within soil, and allowing no irrigation by natural flow. His reply was that the sacrifice of revenue would be so enormous that it could not be thought of. Mr. McLeod, in his paragraphs 13, 14, rightly disposes of this objection. Even were this a necessary and permanent consequence, the other interests involved are of greater importance than the realisation of revenue; and if the other benefits anticipated can be secured, the results would be profitable to the country and to the Government. But perhaps the permanent diminution of revenue also is over-estimated. The Government revenue would in the first instance be reduced,

for all the area irrigated would be charged at a lower rate for water requiring to be raised. But the extension of area irrigated, owing to the greater economy of the water, would again make an addition to this item of revenue, whilst it has the far higher advantage of benefiting, with the same quantity of water, a much larger extent of country, enlarging the shield of protection against unfavourable seasons, and placing a larger body of the people in circumstances of comparative ease and security.

35. It is true that where irrigation by water delivered on the surface is already enjoyed, the proposed arrangement would require more field labour; and possibly, as a result of this, labour generally might become more scarce and dear in irrigated districts. But it is questionable whether in reality more hands altogether would have to be employed, or whether the amount of labour required in connection with irrigation would not be merely a more full and wholesome employment of hands now in great measure idle, where the water required is obtained with so little trouble. Nor is it to be forgotten that the very facility with which the water is obtained, when on or above the level of the land, occasions frequent demands for active exertion without option as to time, and so requires attendance and watchfulness, while water below the surface would give no occasion for anxiety or trouble of this kind.

36. The amount of labour also to raise the water would not require to be great, for the water need not be far below the surface. Just below the surface would answer the ends in view. None of the more costly and laborious appliances for raising water from a depth would be required. Various mechanical arrangements of a simple and economical kind would be used, requiring a very small amount of labour.

37. In Sind, where the irrigation has hitherto been entirely from Inundation Canals, carrying the water generally at some depth below the ground level, and only partially supplying lands on which the water can be run without being raised, it is now desired to have permanent canals, delivering the water on the surface. But the inconvenience felt there, and the dissatisfaction expressed with the present style of irrigation canal, are due to the amount of labour required, for the most part, to raise the water to the surface, and

more especially to the fluctuating height of the supply, dependent on the varying conditions of the river, requiring different applications of labour at different times, and so interfering with all fixed arrangements for employment of available labour; occasioning superfluous expense, and affecting the confidence and comfort with which the field operations are carried on. (*See* Captain Fife's Sketch of Irrigation in Sind, with proposal for its improvement. Selections from Records of Bombay Government, No. LXIX. 1863.)

38. Captain Fife states the requirements of an irrigating canal to be "*first*, that it shall contain a stream, which may be increased or diminished at pleasure according to the demand, and quite independent of the changes of the river; and *second*, that it shall feed or supply the water at a proper level— that is a little higher than the level of the land to be irrigated." (paragraph 59.) And the resolution of the Bombay Government on Capta'n Fife's projects observes, "The last named advantage" (a higher level supply)" is, as a general rule, the only one which greatly increases the revenue. If a man can cultivate a given area when he has to raise the water say three or more feet, it is obvious that if he can obtain water by a smaller expenditure of labour, or, better still, without raising it at all, he can cultivate a very much larger area. Improvements therefore which afford a high-level supply of water directly meet the great obstacle to an increase of revenue, by enabling one man to do the work of many." (paragraph 75.) This observation is made with reference to the scanty population of Sind as the great obstacle to increase of revenue. And it is assumed that by liberating a large proportion of the labour now employed in raising the water for irrigation, a larger area of land will be brought under cultivation and more revenue raised. The argument appears to be applied entirely to the extension of cultivation, not to the higher water rate to be charged on irrigation by free flow on the surface. A large extent of irrigation, it is true, will follow from the arrangements which provide a constant instead of a temporary and fluctuating supply of water. The possible extent of irrigation is dependent on the quantity of water available. But the constant supply having been secured, it will, for the reasons above given, not follow that the quantity of water available will go further when delivered on the surface,

unless it is paid for by volume discharged. So long as we have not the means of satisfactorily carrying out this inducement to economy, the best mode of securing this object, and the maximum irrigating power of a given quantity of water, is by keeping the supply slightly below the surface of the ground, and requiring a known small amount of labour for its application.

39. It should be observed that with watercourses carrying the water only a little below the surface, it would be necessary to adopt measures for carefully guarding against the practice of furtively damming up the watercourse so as to raise the level and obtain a surface flow.

40. One other point, with reference to keeping the distribution channels within soil, has to be noticed. In one of his lectures at Calcutta, Sir Arthur Cotton, adverting to the measures adopted for rectifying some of the evils experienced on existing canals in the N. W. Provinces, by carrying the main canal within soil, observes that this, which has been done on the Ganges Canal on the recommendation of the Committee appointed to report on the project, is a measure of doubtful propriety, and may lead to some of the evils it was intended to correct or prevent, inasmuch as by cutting a deeper channel, a retentive soil near the surface may be cut through, and a more permeable soil reached, which will allow percolation producing swamps, besides occasioning great loss of water (that is, loss of water to the canal and canal irrigation. Much of this percolation goes to raise the water level in adjoining wells). This argument against making the channel within soil may be of force in the case of the larger excavations for main canals, and not with such frequency there as to discourage the arrangement referred to; for the conditions of soil near and below the surface which are assumed in the argument are not general, though they have been found to exist to some extent. More retentive soils are also met with under surface soils more permeable, and advantage gained with respect to the point in question, instead of loss incurred, by carrying the channel within soil. But in any case the argument used with reference to main canal channels would not be applicable to the minor watercourses; and objection on this score could not be brought against the proposal now made by Mr. McLeod.

41. The advantages of the arrangement effectively worked are great. The economy of the water, and consequent extension of the usefulness of any given supply, the enlargement of the area of cultivation secured, the reduction of waste causing unwholesome swamps—these are objects so important that it seems most desirable to try the proposed system on a large scale, as suggested by Mr. McLeod, in laying out the distributing channels of the next of the new divisions of the Baree Doab Canal not yet constructed, with a view to the extension of the system, should it then be seen to be advisable, to the other divisions.

42. With such a system, on which it would be the interest of all using the water to economise it, we should obtain more satisfactory data for a system of contracts than we can have at present.

43. There is yet one method by which the advantages could be obtained of dispensing the water by volume, instead of measuring by area irrigated. Various circumstances before referred to prevent measurement of direct discharge being depended upon and used as the basis of the water rate. But water delivered into reservoirs of definite form periodically filled from the canal channels, and from which reservoirs the field watercourses could be supplied, could be measured with precision. An immovable water-gauge marked on the vertical side of a reservoir would allow of water being supplied in any desired quantity with exactness and according to a measure unmistakeable, and of its being charged for by bulk in the most simple manner like any other commodity. And with a still water supply which could be used at pleasure, and not at particular times only when the water is admitted into the distributing channels, the convenience of the cultivator would be served, while the desired inducement to economy of water would be furnished.

44. "In any system of measurement of water for irrigation," Colonel Baird Smith observes in his Report on Italian Irrigation (vol. II. page 6), "there are two distinct ideas involved, which it is desirable to define clearly, and to keep separate in the mind. There is first the idea of a unity of measure apart altogether from the means which may be taken to insure its application in actual practice. Considerations of expediency will determine in different

localities the special selection of this unity. It is sometimes the quantity of water which issues from an opening of fixed dimensions, with or without a certain pressure; at other times it is the quantity of water which irrigates a given area of land under certain fixed conditions, and so on in different terms under different circumstances; for while one unit might suit the agricultural conditions of Italy, another might better suit those of India. The second idea involved in a measurement system is that of the special apparatus by which the volume of water, as defined in terms of the established units, is measured and issued." With canals employed to feed reservoirs, we should have a third and still more direct and simple mode of measurement of water, and altogether independent of a special apparatus—the second idea above referred to as involved in a measurement system, or rather the special apparatus being simply the reservoir itself.

45. It is of course certain that reservoirs so numerous as would be required for the general adoption of this system on any canal would involve a very large first outlay. But it need not be prohibitory; the system would effect much gain and admit of compensating savings in other ways.

46. The frequency with which the reservoirs would have to be filled would depend on their size. There would be economy of first outlay in making them small. There would be greater advantages in having them large.

47. One special advantage of the use of reservoirs (and particularly large ones) would be this. At present, during the time the canal is necessarily closed for annual clearance and repairs, no water can be obtained for irrigation. This closing of the canal takes place at times specially chosen, when it is not generally likely to lead to inconvenience. But the weather may, during this interval, after the canal has been closed and the repairs commenced, be unfavourable, and water be much wanted. By having the reservoirs filled just before the closing of the canal, there would be a store available in case of necessity, and the inconvenience and loss would be, in great measure at least, if not altogether, provided against.

48. It is scarcely worth while to consider that these reservoirs would likewise serve to store a small supply of rain-water. The

quantity thus collected would not be of great value, but so far as it goes it is another utility of the arrangement.

49. Canal water is at present charged at different rates according to estimated volume, for irrigation purposes and for supply of village tanks. When water is given out by measured volume for both purposes, the arrangements would be simplified by discontinuance of this distinction. Indeed this might be done, though not with the same certainty, even now. It is in reality a matter of no possible concern to the proprietor of the water what is done with it, once it is given out. All that is required is a fixed rate for a defined quantity.

50. Special precautions would of course be necessary in managing a system of water supply to reservoirs, to prevent irregularities. It would probably not be difficult, for instance, to apply a detective syphon gauge, which would check the height to which a reservoir had been filled, and such other checks as might be necessary would be employed.

51. The use of reservoirs, furnishing simple and intelligible means of giving out water by volume with accuracy, would attain the three great objects which have been under consideration—economising water, and so enlarging the area of protected cultivation, as well as preventing abuse leading to unhealthiness; supplying ready and reliable data for contracts; and dispensing with the vexatious and costly periodical field measurements. And if not found open to insuperable objections, the arrangement seems worth a trial.

ROBERT MACLAGAN, Lieut. Colonel,

Secretary to Government, Punjab,

P. W. Department.

Minute on the Revenue Establishments of the Punjab Canals.

The result to be aimed at is to secure economy without sacrificing efficiency, and to utilise existing Government establishments without impairing the independent action of the Canal department.

2. All land irrigated by canals should be assessed for the land tax at dry (baranee) rates only. The Canal authorities should, with the sanction of Government, be allowed to raise the water rate to such a scale as is justified on commercial principles. All percentage allowance to village officials must be taken into consideration when we fix the establishments.

3. I lay great stress on these points, as the percentage of the establishments which are now to be fixed will be greatly affected by the amount of water rate which can be levied; and if we are going to reduce canal extravagance, we must do justice on the other side also.

4. There are two possible ways of assessing the water rate—

A.—By the volume of water discharged.

B.—By the area of land irrigated.

5. It is admitted for the present that the first expedient cannot be adopted; but we ought always to look to that as an object to be attained, and consider our present arrangements as only temporary; and we should collect statistics, even if this caused some increase of cost of establishments.

6. In adopting the second expedient, we have the alternative of—

A.—Employing the Tuhseel establishments.

B.—Entertaining a separate establishment.

The canal requires establishments for the following purposes in the Revenue department, as distinguished from Works and Repairs:—

I.—Protection.

II.—Distribution of water.

III.—Assessment of demand.

IV.—Collection of Water Tax.

V.—Collection of Statistics.

It is admitted on all hands that for classes I. and II. separate Canal establishments must be entertained, and the same may be said of class V.

7. Round classes III. and IV. there ranges a considerable controversy. The extreme right—the canal officers—would entertain separate establishments, as is the case in the Western Jumna Canal; the extreme left would entrust both these duties to the ordinary Revenue establishments in whole or part. I confess that I myself occupy a middle position. I would never surrender the principle that the collection of water tax is to be made by the same officials who collect the land tax (class IV.). Such is the practice in the Baree Doab Canal, and I would at once peremptorily introduce it on Western Jumna Canals, as in fact is already the case with the Raja of Jheend on that canal.

8. But I can go no further: I consider the circumstances of the Baree Doab Canal very exceptional, as irrigation has not nearly reached its maximum or even an average development. For the next five years this canal must have a separate establishment for class III. As regards the Western Jumna Canal this argument will not hold, and I should like to have some further discussion. But for the present I must assume the two canals to be similarly situated.

9. Establishments will thus be required for classes I. II. III. and V.; but we may leave class V. for subsequent discussion, and confine ourselves to the three first classes.

10. Major Gulliver has handed in a scheme, but to bring the discussion to a profitable end we must have proper English nomenclature to each post. It appears to me that the following posts are required:—

Class I.—Watchman .....(Chowkydar.)
Do. II.—Water distributor..(Zillahdar.)
Do. III (1).—Land measurer (Mohurrir paimaish.)
(2).—Chain-man.. ..(Mirduha.)
(3).—Tester.....(Mohurrir pertal.)
Over all would be the Supervisor ..... (Nat. Dep. Collector.)

The exact number and salaries of these officials can be fixed for each division of the canal on a general principle.

11. At present the village lumberdars receive five per-cent and the village putwarry receives one per-cent on the water tax of their village for *general* service. I would propose to allow the lumberdars two per-cent for the trouble of collection, and the village putwarry nothing, for no *extra* work would be demanded from him.

12. The idea has been started that the village putwarries can be utilised, and that a large portion of the duties of class III. could be delegated to them; of course they would have to be paid; the extra duty could not be thrust on them. The canal officers are of course opposed to this measure, and I agree with them, though perhaps from different reasons. I would certainly employ the revenue establishments of Government if I thought that they could do the work, but I do not think that they can without neglecting their own proper duties. Moreover, I look upon the putwarry as a private soldier in a regiment, in which canoongoes are the officers, and the tuhseeldar the commandant; and I object to the putwarry's services being placed at the disposal of canal officers.

13. I feel sure that such a plan would end in grief: the putwarry would play off the canal officer against the tuhseeldar. No man can serve two masters, or render a divided homage; certainly not a village official.

14. The putwarry is the village accountant, not only of one village but of a cluster of villages. In some of them there may be canal irrigation, in others there will not be, *but he is the servant of all*; he must live within his jurisdiction; he is the indispensable witness in every summary suit, the necessary witness in every regular revenue suit; he has to visit the tuhseel periodically to exhibit his diary; he has to note every change in the proprietary; he has to test the village map annually, and to file his annual papers by the agricultural year: great delay even now occurs. The putwarries are not handled satisfactorily: they are constantly absent; the existing arrangements are often anomalous, and in no district final.

15. Now the demand for the water tax must be ready at a certain date; it can only be made up after careful measurements of the land, well tested, and then applied to certain facts, which are only

known to the water distributors. The collections have at once to be made on this demand by the tuhseeldar, and a ready answer must be available to all objections to the entry or claims for remission.

16. The putwarry can never manage this: he is *supposed* to inspect the cultivation of each village, and correct the field map, or at least make memoranda of the changes; but I much doubt whether this is ever done, and it would require a frightful pressure to get it done, and it would never be done in time to enable the collection to be made.

17. I by no means, however, wish the canal officers to revert to the pernicious practice of annual or half-yearly measurements of irrigated area by untrustworthy measurers, nor do they wish it themselves. Once for all let a good field measurement be made of all canal lands or lands capable of irrigation; let a separate field map and index be made, and become the basis of the Canal Revenue Record: and this must be tested every year, and corrected up to date, before the demand paper is prepared. Thus an unusually large establishment will be required this year to conduct the measurement; the putwarry will of course be in attendance, *as it is his duty to be so*, both during the measurement and the annual testing; but it must be conducted by a separate body of men—class III. of the Canal establishment. As regards identity of field, the zemindars must be informed that the canal officers will not supply water to parties who capriciously alter the size and physical appearance of their field. It is believed to be quite unnecessary to do so when once irrigation is established.

Khusrah and Shujrah.

Girdawuree.

Jummabundy abpashee.

Then Captain Dyas' two requirements will be met—

I.—To identify a field when once it has been measured.

II.—To prevent the zemindars from altering its size and shape.

18. In the districts of Goordaspore and Amritsur the settlement officers could have these maps prepared at small cost; in Lahore district and on the Western Jumna Canal the new map must be specially prepared.

19. The salaries of the Canal establishment should be regulated according to the analogous grade of revenue officials holding

similar posts. Nothing is so bad as capricious salaries in different departments of Government service. The same classes of men should be employed, and the machine will work much easier if this point is attended to, and canal men get occasionally promotion in the district office, and *vice versâ*. The natural antagonism of rival departments will die away.

20. However, with a view of satisfying ourselves on the point whether the services of the putwarries can or cannot be utilised, I propose that two pergunnas be selected—Puthankote, in Goordaspore district, and Lahore; and that the duty of preparing the jummabundy abpashee from rubee 1863-64 be specially entrusted to the tuhseeldars, who will work through their own establishments. The canal officers would in those pergunnas entertain no establishments, with the exception of the testers (*mohurrir purtal*), who would follow the putwarries, and check so many fields.

21. I am by no means sanguine about the success of this; but Mr. Robert Egerton states that it can be done, and I have therefore selected one pergunna in his old and one in his new district. The measurements should be at once commenced upon. I understand that Mr. Egerton insists on the field map and index being correct and tested by canal subordinates as a condition precedent to his undertaking to prepare the jummabundy. It must never be forgotten that when the putwarries have made their annual inspection of the field, and have certain columns in their return filled up, showing the area and proprietary, and cultivators and crop, they have still to apply to the distributor of water and watchman, both canal servants (classes I. and II.), to know the facts about the supply of water; and it is just here that the difficulty will arise: the issue will be "did the crop have water, and sufficient water?" On this the justice of enforcing the demand will depend, and just at this critical point there will be a collusion of the canal servants and the villagers, for the putwarry will certainly side with the villagers, whether they are right or wrong.

22. I would make the supervisor Deputy Magistrate, and vest him with the power of a Sub-Magistrate of 2nd class under the Sessoins Judge, and of a Deputy Collector under the Commissioner

of Revenue. The officers appointed should be well paid and carefully selected.

My propositions are therefore—

I.—That all canal land be assessed at baranee rates.

II.—That the water rate be at once raised and fixed on commercial principles.

III.—That the percentage paid to lumberdars and putwarries be included in the schedule under consideration.

IV.—That separate establishments be maintained by the Canal department for classes I. II. III. V.

V.—That on the Western Jumna Canal the collections be at once transferred to the tuhseeldars.

VI.—That a moderate but sufficient scale of establishments with a fixed English nomenclature of posts, and a scale of salaries analogous to the other Revenue establishments of Government, be fixed.

VII.—That the experiment of employing the putwarries be tried in two pergunnas.

VIII.—That two per-cent be allowed to lumberdars for the trouble of collection. If the water tax is properly raised and irrigation extended, this two per-cent will be as good as four per-cent on the old rates.

IX.—If the putwarries are employed, they must receive two per-cent on the collection for their extra trouble; if they are not employed they should get nothing.

X.—That zemindars be warned that if they alter the shape of their fields after they have once assumed a proper contour for irrigation, the canal officers will refuse to deal with them. We cannot compel them to leave their fields unaltered, and they cannot compel us to give them water.

23. I am sorry to see that the contract system has been abandoned on the Western Jumna Canal; this seems a retrograde step. We should look to contracts as our great object, whether we arrive at the data on which a contract can be based by measurement of water discharged through a regulated outlet, or by a consideration of the statistics of area irrigated for a long period of years, it matters not. We can afford to give a contract at something less than measurement rates if we are enabled to reduce establishments. The only

system which can be contemplated with satisfaction is that of contracts based on mutual advantages.

24. I can see no reason for bringing the Revenue establishments of a canal on a Public Works Budget. The schedule should be fixed annually by the Local Government and charged to the gross income of the canal. When the amount is fixed, we shall be able to assign a certain percentage for cost of revenue management. As irrigation extends and the income increases, the Revenue establishments will increase but the percentage will remain the same.

25. We had two meetings of our Committee, in which there was much interesting, though desultory conversation. I can see no advantage in any more meetings unless some specific issue be raised to which the discussion is to be confined. I conceive that if this Minute be circulated, members can record their opinions, and Captain Dyas and Major Merrick can be heard. The Government will then be in a position to act.

ROBERT CUST.

Lahore, 14th April 1863.

Memorandum on Bari Doab and Western Jumna Canals.

I have been allowed a perusal of Mr. Cust's Memorandum upon Canal establishments, recording the conclusions at which he had arrived as the result of two meetings held at Lahore of a Committee appointed by Government to consider this subject; and as the matter is one intimately affecting the interests of the Revenue Administration, I think it right to place my own views also on record.

2. I concur in the main with Mr. Cust, whose paper puts the subject in a very clear light, and deals with it in a manner well calculated to facilitate an ultimate decision on all moot points; and I will accordingly advert only to those points in connection with which I either differ from him, or would add to the arrangements which he proposes.

3. It seems to me that as regards the interests of the canal in its fiscal relations, the most important branch of its operations is that connected with the *distribution of water*. As regards the

interests of the people, on the other hand, I would attach the most importance to Judicial establishments for the *adjustment of disputes*. The former of these does not occupy so prominent a position in Mr. Cust's scheme as I think it deserves, while the latter is not recognised or dealt with as a separate department at all.

Distributing Establishment.

4. As regards the first of these, viz. the distribution of water, it must be apparent that it is a duty of the most responsible character, and one which must absorb the time and attention of very much the largest portion of the fiscal establishments of the canal. It is in this department that by far the greatest opportunities for peculation, favouritism, and injustice must occur, as in dry seasons especially large sums will readily be given by zemindars for a copious supply of water at the critical moment. All sorts of fraudulent practices on the part of the zemindars have to be guarded against, as well as peculation and collusion on the part of the Canal establishments, and efforts to prevent or counteract these must be continued during the whole period that water is being drawn from the canal.

5. For so delicate a duty I consider that a very reliable and trustworthy description of establishments should be provided. At present it is performed by chowkidars acting under the control of zilladars and their deputies, and I doubt much whether the pay of either of these classes is such as to render them proof against ordinary temptation. If this duty were effectively and faithfully performed, I believe that the other duties of measuring and assessing would be altogether subsidiary, and the charge on account of these might be reduced to a minimum. I would strongly advise therefore that these establishments be put on a thoroughly effective footing. Whether their numbers could or could not safely be reduced, I cannot undertake to say, but I am of opinion that the scale of monthly pay for an ordinary chowkidar ("Mehr-ad" as he is called in Peshawur) should certainly not be less than 6 rupees, while there should be superior grades drawing 7 and 8 rupees respectively, with jemadars drawing 10 and 12 rupees, to keep them under control. The zilladars or overseers and their naibs should, I think, in like manner have gradations of

pay, the former ranging from 50 to 80 rupees per mensem, the latter from 25 to 40 rupees, with darogahs or superintendents over them ranging from 100 to 150 rupees.

Judicial Establishments.

6. The other department to which I have above referred—that of Judicial establishments for adjustment of disputes—does not appear to have been in any way provided for since Mr. Birnie Browne was withdrawn from the canals, and I consider it most essential that it should be so without delay. It is not to be expected that officers selected for their engineering qualifications, and untrained to judicial proceedings, can as a general rule be qualified for hearing and disposing of complaints brought by zemindars or others, and I should anticipate the occurrence of very great evils if this matter be not looked to at an early date.

7. I agree with Mr. Cust in thinking that the functionaries entrusted with such investigations should be of the grade of Extra Assistants, and assimilated to these in gradations of pay, though whether their interchange with those employed in the general Civil Administration would be expedient may, I think; be doubted. I would have it understood that the primary duty of these functionaries must be the adjudication of disputes; but there would probably be no objection to their exercising a general control over other establishments, especially those engaged in measuring and testing.

8. In principle these establishments should, I think, in their judicial capacity at all events, be independent of the Canal officers; and if ever canals be made over to private associations, they must necessarily be rendered so. But Captain Dyas is of opinion that an appeal should lie from them, in the first instance, to the Executive Engineer; and if he deliberately adhere to this opinion, I would not oppose him—for the present at all events.

Measuring Establishments.

9. As regards the work of measurement and assessment, I have remarked above that if the duty of distribution be effectively conducted, I believe the requirements for the other duty may be reduced to a minimum. But however this may be, I agree with Mr. Cust in thinking it must remain under the canal officers; and for the reasons given by him, I should consider it wholly inappro-

priate to entrust this duty to the putwarries, insomuch that I would altogether deprecate even the partial experiment which he consents to concede in a few pergunnas. A copy of the Shujrah of each village, prepared in connection with the Settlement, may appropriately be made over to the Canal, with all alterations noted on it that may have subsequently taken place ; but it will still be necessary for the Canal establishments to test and satisfy themselves of its correctness.

Maintaining form and distribution of fields unaltered.

10. I am not prepared to support any proposition prohibiting all alterations in the size and shape of fields. But I would make it obligatory on the putwarry to report to the Canal department, immediately after each sowing has been completed, any changes of these that may have been effected. The proprietor of the land might be held jointly responsible, and penalties might be attached by the legislature to the omission of this report. Whether a system of contracts will ever be practicable remains to be seen. I doubt it myself, as it would be likely to fetter the department in regard to improvements, arrangements for distribution, and in other ways. But however this may be, if the several departments of work be systematised and placed on a really efficient footing, I believe that both the cost and the harassments attending the half-yearly measurements will be reduced to something very inconsiderable.

Remuneration of Lumbardars and Putwarries.

11. Lastly, as regards the remuneration of Lumbardars and Putwarries, I can conceive no reason whatever why the percentage allowed them should be less for their duties connected with Abiâna, than for those in connection with the ordinary Land Revenue. As regards the enhanced rate of Abiâna, it is obvious that whatever increase is made in this, there must be a corresponding decrease in the Land Revenue ; while the responsibilities of the Lumbardar in regard to general control, supervision, and collection will remain the same. The responsibilities of the Putwarry, in like manner as to accounts and records of all kinds, will be the same as regards this item of revenue as in respect to land revenue, and I look upon it as of very great importance that in all cases of dispute his evidence shall be available to the canal

judicial authorities, and that he be required therefore to keep himself informed as to the state of affairs in connection with irrigation, no less than with cultivation. The Lumbardar and Putwarry should, I think, be regarded to some extent as a check upon the Canal establishments.

12. Having now adverted to all the points on which I have to any extent differed from Mr. Cust, I would very earnestly second his representation as to the absolute necessity for entirely separating these establishments and their cost from the Public Works schedules. Whether they be provided for by a percentage on the income, or drawn for in abstracts according to schedules previously sanctioned, it is quite obvious that they are fairly chargeable against the revenues derived from irrigation, and cannot properly be regarded as a Public Works charge. So long as they continue combined with the establishments for construction and repair, an injustice is done to the department of Public Works, while justice will not be done to the fiscal interests of the Canal until this is rectified.

D. F. McLEOD,

1*st June* 1863. Financial Commissioner for Punjab.

From D. F. McLEOD, Esq., Financial Commissioner, Punjab (No. 2015, dated Lahore, 4th June 1863), to the SECRETARY to GOVERNMENT D. P. W., Punjab.

REVENUE.

Arrangements for economising the water supplied by Canals.

SIR,—Having recently forwarded to you (demi-officially) a Memorandum on the subject of establishments for the fiscal administration of Canals, I have now the honour to offer the following remarks on a branch of the subject not referred to therein, viz. arrangements for economising the water supplied by canals.

2. That it is very desirable to economise the supply of water is no doubt generally felt and admitted, but to realise and appreciate the immense interests that are involved, it seems to me that we must

look deeper than many of us are wont to do, and I purpose accordingly to advert separately to each of the following considerations, which I regard as comprising the principal points to be dealt with in discussing the subject:—

1*st.*—The importance of turning to the fullest account, in the interests of the agricultural population at large, the limited supply of water available for each of our permanent canals.

2*nd.*—The duty incumbent upon the Government, of preventing such flooding of the country as must prove injurious in a sanitary point of view.

3*rd.*—The desirableness of regulating the supply afforded to each individual, with a view to render our taxation just, equal, and easily adjusted.

Extending irrigation to its utmost limits.

3. As regards the first of these, I would observe that in my opinion the most important function of canals or other artificial means of irrigation in India is that of •PREVENTING FAMINES. However great may be the gain to the country and the Government of extending cultivation and population, and increasing production, I regard it as a much greater gain to be able to guard against famine over the area so cultivated. It is, I believe, a very general impression both here and in Europe that improvement of communication, by equalising prices of food, is the one measure required to prevent famines; but this appears to me to be quite a mistake. The equalisation and lowering of prices which improved communications must effect will no doubt be an immense boon, and the increased activity and progress in the nation at large, necessarily resulting thereupon, will afford greater scope for the starving agriculturist to find occupation; but famine, properly so called, only occurs when the preparation and sowing of the land has become impossible from want of rain; and the liability to this can only be averted by artificial irrigation of a reliable character.

Which, however important as a means of increasing production, is mainly urged on the ground that irrigation is the only effectual preventive of Famine.

4. Where a crop has been sown, but the out-turn proves deficient, great distress will no doubt be experienced, but there will not be a real famine. Where, however, the land remains

unsown, the occupation and the credit of those who have no capital and wholly depend on agriculture are at an end, famine being the necessary result. In the Peshawur valley wheat flour was selling in December 1854 at 6 or 7 seers per rupee, which is a higher price, I believe, than was at any time attained in the famine districts during 1860; yet there was no famine, as the people were employed, and a harvest was in prospect; and none of those appalling scenes occurred which were witnessed in Delhi, Goorgaon, and elsewhere during the late famine period.

5. Those who have witnessed such scenes will fully appreciate the terrible character of the danger which we have ever at our doors, and the vast importance of everything which may tend to avert it. Happily for India, however deficient the rain-fall in the plains may be, the supplies derived in various ways from the hill regions always keep our rivers more or less filled. They never dry up, as the Nile must have done on the few occasions when a famine is recorded to have occurred in Egypt. And although towards the close of the spring harvest their waters sometimes fall below the desired level, I believe that no deficiency is ever felt when the land has to be prepared for and sown with crops of that harvest. The cultivation of the soil therefore, and the production of a crop more or less abundant, being an absolute certainty wherever the water of our canals can be conveyed, how paramount a consideration it becomes that the available supply be made to go as far as possible.

Prevention of flooding as productive of disease.

6. The next point on which I have to remark is that which relates to the unhealthiness caused by canals. How fearful have been its effects in the alkaline soils watered by the Western Jumna Canals the Government is well aware. But familiar instances of unhealthiness in a less aggravated form might be adduced from many quarters. It has been urged that where a canal is carried along a watershed, the same evil results will not ensue as where its alignment is defective; and this no doubt is true. But nevertheless experience appears conclusively to show, and all fresh inquiries corroborate the fact, that wherever flooding takes place, and the water is allowed to stagnate, there spleen disease and fever

are sure to follow, insomuch that not a few of our medical men anticipate an entire change in the sanitary condition of the country watered by the Bari Doab Canal when it shall have been a few years in operation. Of what moment then it must be to devise, if possible, some method by which the supply of water may be regulated and flooding prevented!

Equalising the incidence of the Water Tax.

7. The third point which I have noted above as calling for remark is the inequality of incidence of the water tax under existing arrangements, and the desirableness of amending this if possible. All attempts to measure the flow of water have entirely failed. The actual measurement of area irrigated involves many sources of uncertainty and inequality, especially in consequence of the great difference in the amount of water absorbed by different crops, so that even where these are charged at different rates, a mere rough approximation to the truth is all that can be attained. The evils and grounds of dissatisfaction resulting from this inequality, it cannot well be doubted, are many and various.

8. Having now adverted to the principal evils which appear to me to result from the want of a method by which the supply of water can be regulated, I proceed to consider whether this want can be supplied, and how.

9. If a module could be devised capable of showing with even tolerable correctness the flow of water through any given aperture, this most desirable object would be attained in the most satisfactory manner: every cultivator would be charged in porportion to the quantity of water he received. The people themselves would take care that there should be no waste, and flooding might, I believe, be entirely prevented. But the large majority of officers most competent to judge appear now to despair of its ever being possible to apply such a module here. Captain Dyas states that a velocity of $2\frac{1}{2}$ feet per second is necessary to prevent silting; that where the silting is at all considerable, no module can act; and as it is quite impossible to obtain in our râjbahas or main water-courses, except near the head of the canal, a slope anything approaching that required to secure the above velocity, he entirely abandons as hopeless all endeavour to measure by means of a

module ; and I am myself strongly impressed with the belief that he is right.

10. The only other method, it appears to me, by which the supply of water can be controlled is by keeping our supply channels *below surface,* so that water can only be supplied to the fields by the application of some mechanical arrangement for raising it, and it is with a view to urge inquiry and collection of statistics on this point that I now address you.

11. I lately inquired of Captain Dyas what he would think of such a measure, and his reply was that the sacrifice of revenue would be so enormous that it could not be thought of. I have since learned that owing to the unhealthiness produced by canal irrigation around Amritsar, its adoption there has been determined on, and that although a large outlay is considered necessary in order to carry it out, the required amount has been sanctioned.

12. What engineering difficulties might be involved in the adoption of the principle generally, I am not competent to judge. It would no doubt be a most serious matter if it should involve a remodelling of either our canals or râjbahas as they at present exist ; but it seems to me that no such necessity would exist if mechanical devices can be suggested by which the height of water at the head of the smaller distributing channels might be kept uniform, in somewhat the same way as the supply of water to smaller cisterns from larger ones is ordinarily regulated.

13. As regards the loss of revenue, I think it not unlikely that it might ultimately prove less than may at first sight appear. The height to which the water would have to be raised, and the consequent amount of labour required, would be small, while improved methods for applying this labour, of a simply but effective character, could doubtless be devised so that there should be no very serious diminution in the value of the water to the cultivators, while the increased area from which a water tax would be obtainable should go far to make up the difference.

14. The other interests involved however, upon which I have dwelt in the foregoing paragraphs, appear to me to be in the aggregate of vastly greater importance than the realisation of revenue ; so that even if there should be a considerable loss of income, yet if the

other benefits resulting from the power to regulate the supply of water, can be secured, I believe that the country and the Government would be very greatly the gainers.

15. The extension of irrigation from the the Bari Doab Canal appears to me to afford an admirable opportunity for putting the question to a practical test, if there should not be valid reasons to preclude a trial being made at all. The supply of water from the Râvi is wholly inadequate to afford a moiety of the irrigation required for this Doab, so that nowhere can the utmost economy of water be more indispensable. In the comparatively moist tracts near the head of the canal some, no doubt, would refuse to pay for water if labour were required to raise it to their fields ; but this would be a boon to the thirsty tracts lower down, where artificial irrigation is an absolute necessity, and where, in consequence, no such objections could prevent the people from gladly taking water; while in tracts to which no water has hitherto been supplied, Government is entirely free to enforce such conditions as it may deem advisable.

16. Irrigation is the great want of most parts of India—of none perhaps more than of many portions of the Punjab. The subject is one which yields in importance to none. If then my suggestions should be deemed impracticable, I trust I shall not be regarded as having gone out of my province in thus urging them.

I have the honour to be, &c.

D. F. McLEOD,
Financial Commissioner for the Punjab.

Memorandum by the Secretary to Government Public Works Department.

The main questions discussed in these interesting papers are—

The mode of assessing the water rate on irrigated land; and establishments to be employed in collecting Canal revenue.

2. By common consent it has now been settled that any attempt to deal with water as it is usual to do with most other commodities must result in failure, *i. e.* it is not now practicable to measure and serve it out in defined quantities as it is possible to serve out grain or any other article which can be correctly measured and paid for by well-defined quantities, and the result is that at present assessment has to be made on irrigated areas.

3. But here again is a difficulty : all crops do not require the same quantity ; some will absorb more than others, and when the supply in the canal is not a maximum one, all lands cannot get as much as they require, and discretion must be used by somebody in regard to the distribution.

4. The question is, can the distribution be made by Canal officers, and the assessment and collections by the ordinary Revenue establishments. With water unlimited this arrangement might do, but when the supply is scanty it is otherwise. The department entrusted with the distribution is alone in a position to know how the water has been disposed of, and is alone able to meet objections, on the part of cultivators, that they have not had their fair share, &c.

5. In all new irrigating works therefore, and until a series of years' experience has put the question of demand and supply on a firm basis, I think the entire Canal management in the case of extensive irrigation works should be in the hands of the Canal officers.

6. On this side of India we have not, or we shall not have, the same difficulty that is experienced in the N. W. Provinces in regard to the measurement of irrigated areas, for we have a more complete system of revenue survey, and with us field boundaries are not varying. This portion of the duty of Canal officers will therefore with us be very much lightened ; it will only be necessary to see whether such and such a number has received a fair supply of water, and to take the area from the survey map ; but there will still remain the difficulty as to the nature of crops, the quantity of soil, and the extent of the available supply.

7. The best way of dealing with this difficulty would be to employ only two or three different rates, and to keep them low enough to leave a large margin of profit to the cultivator, so that there would be no reasonable ground of complaint if the supply should not always be a maximum one.

8. This, and as careful and judicious a distribution as possible, appears to be the only practical solution to a varying problem in the absence, for the present only it is to be hoped, of some method of measuring water, and of arriving at some means of establishing a system of contracts, which of course cannot be done till it has been ascertained, in a satisfactory manner, what quantity of water is required under given circumstances, and how that quantity can be delivered with certainty.

9. Colonel Maclagan suggests the establishment of distribution reservoirs into which the water may be measured and made over to the cultivators, but he does not seem quite satisfied with this expedient, which would in any case be very costly, and which, however it might answer in connection with the delta plains and rivers on the other side of India, is certainly not practically feasible with us.

10. Another important point discussed is Mr. McLeod's proposition to keep all irrigating channels just within soil. This it is considered, by involving a small amount of labour to put the water on to the land, would tend to economy, check waste, and lead to results by which a better understanding could be arrived at on which to base contracts. On the other hand it is asserted that it would lead to loss of revenue.

11. On the other side of India they have two rates of assessment—"Toor," *i. e.* natural flow without manual labour, pays say one, and "Dall," *i. e.* where manual labour is necessary, pays half, so that universally to convert all natural flow irrigation into "Dal" would be to surrender half the revenue of the canals.

12. But it is urged that if compelled to economise water, the cultivators would make the supply go further, and the reduction of irrigated area would not therefore be so great as on first thought it might be supposed to be; while, as it is proposed that the canals should be so arranged that only a very slight amount of labour would be required to put the water on the surface, the same population would be able to cultivate very nearly the same area as at present.

13. This arrangement is ingenious, and no doubt has many of the advantages claimed for it; but Captain Dyas, perhaps the best authority on irrigation now in India, is opposed to it; though Colonel Maclagan, whose opinion is also very valuable, is in favour of it.

14. I think other Papers should be sent to the Revenue Commissioners, Commissioner in Sind, and to Colonel Fife for their opinions on the question raised, and though no immediate or practical good, as far as we are concerned, may arise from the discussion, yet, as tending to fix ideas on a subject which must in a short time occupy a great deal of attention, it is advisable to put the officers who will have to deal with such subjects in possession of the difficulties which are experienced elsewhere.

M. K. KENNEDY, Lieut. Colonel,
Secretary to Government.

12th March 1864.

Irrigation Canals.

No. 622.

REVENUE DEPARTMENT.

Bombay Castle, 24th February 1864.

Memorandum from the Secretary to the Government of the Punjab, No. 3916, dated 19th December 1863—Forwarding a copy of printed Papers on Canal Revenue Establishments and distribution and economy of Water, and requesting to be favoured with any remarks on the points adverted to in those papers which may aid in leading to practical conclusions on the subjects discussed.

RESOLUTION.—Copies of these papers should be forwarded to the Commissioner in Sind and the two Revenue Commissioners, as also Captain Fife, and they should be requested to favour Government with any observations and suggestions they may have to offer on the subject therein discussed, after consulting the Superintendents of Revenue Survey, or other officers under their respective controls they may consider it desirable to consult.

J. B. RICHEY,

Officiating Under-Secretary to Government.

To the COMMISSIONER IN SIND.....
REVENUE COMMISSIONER N. D.....
REVENUE COMMISSIONER S. D.....
Captain J. G. FIFE, R. E., Superintending Engineer Irrigation Department.....

With copies of the papers referred to in the Resolution.

Agricultural.
Irrigation.

No. 544 OF 1864.

PUBLIC WORKS DEPARTMENT.

From Colonel C. W. TREMENHEERE, *C.B.*,
Chief Engineer in Sind,

To S. MANSFIELD, Esq.,
Commissioner in Sind,

SIR,—I have the honour to return the printed papers received with your Memorandum No. 2652, dated 30th December 1863, and to forward copies of Captain LeMessurier's and Lieutenant Smith's replies* to my reference upon the subject.

* Not forwarded.

2. I beg to offer the following remarks upon Mr. McLeod's proposal, as stated in page 10 and the following pages.

3. Mr. McLeod contrasts the expenditure of water in cases in which irrigation is effected by natural flow, and in which the water

has to be raised by mechanical means; he shows that in the former case though the water is charged at a higher rate, it is not economised, but that it is so in the latter. Mr. McLeod's proposal is, that distributing channels should be so arranged as to render the former mode impossible.

4. I entirely assent to the correctness of Mr. McLeod's statements, but a consideration of the circumstances has led me to form opinions as to the remedial measures to be adopted which are at variance with those put forward by that gentleman.

5. Land watered by machinery is prepared with great care: the main and subsidiary water channels are laid out so as to distribute the supply to each of the small plots into which the land, carefully levelled, is divided by small bunds, so as to retain a sufficient quantity of water. It is the interest of the former to economise the water; for in proportion as he does so will be the area of the crop which will arrive at maturity and the measure of his profit. The cultivator, under these circumstances, is most careful and economical in the use of water, and it may be said that no waste is allowed.

6. Land watered by natural flow is generally much less carefully prepared. The common khurreef crops (jowaree, bajree, and till) are often injured by an excess of water which is allowed to flow over the land by making an opening in an adjoining kurriah, and a large quantity is allowed to run to waste in the jungle.

7. The conduct of the Sindee cultivator under the two systems affords a striking contrast. Mr. McLeod observes that the easily-obtained water is not economised; but the waste in this case is not, I submit, owing to its being easily obtained, but to the abundance, or rather the superabundance of the supply in relation to the wants of the farmer, he has no motive of (for) an economical use of water, which, if he were to close the outlet, would pass on to another well in which he has no interest.

8. The question for consideration is, whether the supply can be so arranged as to make it the interest of each cultivator to

employ water delivered on his land by natural flow with the same regard to economy as we know him to manifest in the case in which he has to raise it by machinery.

9. I believe this object can be attained by limiting the supply to what may be absolutely necessary for the irrigation of each season's crop, even when employed with as much attention to economy as when machinery is used. The cultivator would thus be forced, by a regard to his own interest, to take the same trouble to lay out the distributing channels, level the ground, and prevent waste in this case as he now does in the other.

10. I do not think there can be a doubt of success attending an attempt to introduce such a reform upon canals like those of the Baree Dooab and the Mitrow—both still unfinished—by limiting the water supply to each estate very strictly by masonry works, and not allowing upon any pretext any addition to the quantity discharged.

11. A system such as I have endeavoured to sketch, if introduced in conjunction with leases for terms of ten, twenty, or thirty years, would, I believe, not only meet nearly all the objections against the delivery of water above the surface, but would embrace the advantages claimed for Mr. McLeod's proposal in pages 14 and 15. It would also render it unnecessary to resort to a system which involves the universal employment of machinery, the result of which must not be measured merely by the loss of revenue it would entail, but chiefly by the much more serious loss to the country, owing to the enhanced cost of production, and the restricted area which could be cultivated, of which the loss of Government revenue would be merely the exponent.

I have the honour to be, &c.

C. W. TREMENHEERE, Colonel, R.E.,
Chief Engineer in Sind.

Chief Engineer's Office, Turr Bhandee,
27th February 1864.

No. 56 OF 1864.

PUBLIC WORKS DEPARTMENT.

The Commissioner in Sind has the honour to submit for the information of Government copy of a letter, No. 544, dated 27th ultimo, from the Chief Engineer in Sind, on the subject of the distribution and economy of water for irrigational purposes, discussed in the printed Papers received with Government Resolution No. 662, dated 24th ultimo, and to state that he entirely concurs in Colonel Tremenheere's view of the question.

S. MANSFIELD,

Commissioner's Office, Camp Sukkur, Commissioner in Sind.
31*st March* 1864.

No. 453 OF 1864.

PUBLIC WORKS DEPARTMENT.

To the SECRETARY to GOVERNMENT,
Revenue Department, Bombay.

SIR,—I have the honour to acknowledge the receipt of the Government Resolution No. 662, dated 24th February 1864, with its accompaniment, on the subject of Canal Revenue, the measurement of Water, and Canal jurisdiction in the North-West Provinces, and to submit with much diffidence my views on those interesting points which have already engaged our attention in Sind and in the Deccan, but for the better elucidation of which we have been eagerly awaiting the result of the trials of different systems on the Ganges and other Canals.

2. The principal facts explained in the interesting papers forwarded from the Punjab are :—

1*st*.—The failure of the module for measuring water by volume.

2*nd*.—The waste of water where the irrigation is by natural flow, and the unhealthy swamps that are caused by such wastage.

3*rd*.—The great expense of maintaining separate establishments for the frequent measurement of the irrigated lands and for the collection of the ordinary Land Revenue.

3. To correct these disadvantages it is suggested that—

1*st*.—Tanks might be constructed to be filled at intervals from the canal under the direction of the Canal establishment, and thus measure the water out to the cultivator with a very great degree of accuracy.

2*nd*.—The alteration of the system of irrigation so as to prevent the water being anywhere used without the aid of at least some machinery and labour to raise it to the level of the land.

3*rd*.—To entrust the measurement of the lands and the collection of the revenue derived from the irrigation to the regular revenue establishment.

4. In venturing to express an opinion on these points I must premise by stating that I have never seen the country in which it is suggested to make these changes. I have before me only the very flat country of Sind and the very steep and rough Deccan. They are two opposite extremes, and therefore the conclusions I have arrived at may not apply to the Punjab. With respect to the measuring-tank system, it appears to me that in a very flat country the tanks would entail a loss of head which could not be afforded, and that in a steep one the expense of constructing so large a number as must be required would be enormous, while in both cases the clearanceof the silt from the tanks would be a source of vast expense, because it must be remembered that the whole of the silt,

including what is commonly borne along by the current on to the fields, would be deposited in the tanks. The fields would thus be deprived of valuable manure, and the cost of the clearance of silt would become a heavy annual charge. In Sind the cost of the clearance would be enormous; in the Deccan much less. It has often seemed to me that since the people are allowed to use the water for perhaps one-tenth or one-twentieth part of its actual value to them, an apparatus which will even approximately measure the volume of water is all that is absolutely necessary. What is principally wanted is an apparatus which will measure water even approximately, and which at the same time shall be as secure as possible from any interference whatsoever, whether by the Canal establishment or by the cultivator.

5. It is understood by us on this side of India that the main cause of the failure of the module is the collection of silt in the intermediate chamber; but if this causes no more inaccuracy than one-fourth of the volume of water discharged by the apparatus, I should not be disposed to condemn it. We are already aware how very unequally natives divide water among themselves, and yet how well contented they remain. Some rough measurement is adopted which is really far worse than inaccurate as far as measurement goes, but it removes the grounds of the quarrel sufficiently to prevent constant altercation, and those who fought for every drop of water before are at length satisfied with a very unequal division.

6. In the late published report on the Ganges Canal it is mentioned that various ingenious devices have been contrived for measuring the water, but that they have been unsuccessful. We are not aware what the contrivances were, nor what degree of accuracy of measurement was attained, but I may mention that two plans have been discussed by the officers of this department, and that we propose trying them upon some new works under construction in the Deccan. One consists of a simple slit in a masonry wall at the side of the canal, through which the water discharges itself into a wide trough, the level of which can never vary, owing to the large

ness of its perimeter over which the water spills. The depth of such a slit depends upon its position on the canal. If near the head of the canal its depth will not be nearly equal to the depth of the canal, but if it is at the tail it will be the full depth of the canal. The width of such a slit or notch is to be decided upon after the probable quantity of water required has been ascertained. This plan must cause a loss of head equal to the depth of the slit or notch, but it might generally be applied where the loss of head could be afforded, and it possesses this great advantage that it may be so placed as to always draw off about the same proportion of water to the whole supply in the canal whether that be large or small. Within considerable limits it would be self-regulating, and so simple in construction as to be fully comprehended by every native in the country. It is not pretended that the arrangement is a perfect one, but merely that it is sufficiently accurate in its working, and secure from tampering as to give grounds for hoping that it will give universal satisfaction. In the event of extraordinary interruption in the canal's supply and scarcity of water, it would be necessary to resort to one of the bye-laws laid down by the late Colonel Baird Smith, which empowers the canal officers to close sections of the canal temporarily for the purpose of forcing the water in greater quantities into other sections, which in their turn would have the water shut off from them. The distribution of the water during such a contingency would be effected by giving the whole supply for a limited time to each section of the canal in succession.

7. The other apparatus which has been discussed as merely a low but wide weir thrown across the distributing channel. The weir is to be divided off into lengths proportional to the demand for water by each village or each cultivator, and the shares of water thus divided are to be led off to the fields by separate small channels commencing from the weir. The length of the weir will be regulated by the head of water or loss of head which can be afforded. It is only necessary that there should be a clear over-fall,

or in other words that the weir should not be a "sunken" or "submerged" one. A fall of 2 or 3 inches would suffice. To prevent any accumulation of silt taking place on the upper side of the weir and affecting the discharge over the different portions of the length, the floor of the canal where it approaches the weir is to be of masonry, and regularly swept either by the canal establishment or the villagers, if they will agree to attend to the apparatus. This arrangement like the other one is simple, and would be understood by the cultivators, at the same time that it cannot be tampered with without discovery. The villagers if they had the management of it would keep a watch over each other. The plan seems to us to be well suited to the distribution of water in small branch channels.

8. In both plans no interference with the water can be attempted by any person without the act being apparent to those interested in the correct sharing of the water, and any attempt on the part of a cultivator to draw off more water by deepening or enlarging his channel cannot affect the supply, while if he does not attend to his channel and keep it clear he will get less than his share. This last case, however, does not call for attention, as the tendency is always to enlarge the channels with the object of obtaining more water.

9. The apparata just described may not meet the views of the canal officers in the Punjab, and it is probable that they have already met with all the attention they deserve as applied to the Punjab canals. We, however, anticipate success in their application to the Deccan; but at the same time we shall be most grateful to Captain Dyas if he will give us any other plans which may have been devised by himself and the many able and experienced Canal Engineers in the Punjab.

10. I will now pass on to the second part of the subject, viz. the alteration of the canal levels so as to wholly put an end to irrigation by natural flow, and compel the people to use machinery

and at least some labour and expense to raise the water again to the level of the fields. On this point I entirely agree with the opinion expressed by Captain Dyas, that the loss of revenue would be far too great a sacrifice. But there are, I think, other points besides the loss of revenue which call for consideration—

First.—Such an arrangement will entail a considerable increase of expenditure on the canals, as much as would in the case of works in the Deccan and Sind provide for the most complete system of escapes, either channels to lead the waste water into natural drainage channels, or tanks to store the waste water. In the latter, arrangements might probably be made for again disposing of the water for the irrigation of lower and more distant lands.

Second.—The loss of revenue does not in all probability represent the whole expense of raising the water to the level of the fields by machinery.

In Sind the cost of raising water from the inundation canals, whose surfaces average about five feet below the level of the fields, was ascertained by the revenue officers to be Rs. 1½ per beegah or about Rs. 2 per acre for one ordinary crop ten years ago, and as prices have almost doubled since that time, and are still rising, the enormous expense to the country of raising water will be understood. Rice and sugarcane, which require about twelve times as much water as the ordinary grain crops in Sind, are not included in the rate given. Rice is always cultivated in spots where the water will run by natural flow. Sugarcane has to be irrigated after the inundation subsides as well as during the inundation. Its cultivation is confined to a few spots, and the raising of the water per acre varies according to circumstances from Rs. 30 to Rs. 50 per acre. The cost of raising water was ascertained by the revenue officers from various sources and in various parts of the country, and their inquiries were made without any reference to a new canal system which at that time had not been laid before them.

The information was collected in connection with the settlement arrangements which were then under consideration for the province. The results arrived at therefore are worthy of more reliance than if they had been obtained by myself or any other officer who advocated the high-level system, and who might be insensibly misled by a bias. The result of my own inquires corresponded pretty closely with what the revenue officers ascertained, while actual experience in raising water for a field which I cultivated for amusement showed the expense to be much greater.

11. In order to make the canals sufficiently below the level of the fields, to prevent natural flow by the furtive damming up of the watercourse, alluded to by Lieutenant Colonel Maclagan in his summary, and to cover ordinary undulations of the ground crossed, it would, I think, be necessary to lower the canals somewhat more than would on first consideration appear necessary. The carrying out of the system completely would therefore generally oblige the cultivator to raise the water to a greater height than is supposed. To this must further be added the height to which a slender stream of water from a machine must be raised to run properly from the machine to the fields. This cannot be less than a foot, and for the more distant fields it will amount to two or three feet. Altogether therefore the cultivator will have to raise the water perhaps three feet on the average, and the expense of this will be very heavy indeed. I observe that some reliance is placed on the idea that the raising of water may be cheapened because of the simpleness of the machine required for a low lift, but I think that actual practice, all circumstances taken into consideration, proves the contrary. It is, I believe, cheaper to raise water per foot of lift by means of a pump or a Persian-wheel worked by steam or cattle than it is to raise water per foot by machines worked by men, and the only reason that men are ever employed to work such machines, or that the small machine is used instead of the large one, is that the quantity of work to be performed at the

spot does not render it worth while to go to the expense of applying better machinery. But the cost per foot of lift is far greater by the small machine than the large one. *

12. After the most careful consideration of the subject of irrigation by natural flow, I find myself obliged to differ from the opinions expressed in the papers received from the Punjab. There must be a large loss of revenue, as so distinctly stated by Captain Dyas, and there must be, I believe, a far greater loss to the people generally, while the cost of cultivating rice will be so largely increased as to materially affect the price of that most wholesome food in the market. I cannot help expressing a most decided opinion in favour of the natural flow irrigation wherever it can possibly be practised, and I believe that all its injurious effects in a sanitary point of view can be completely guarded against by the construction of proper escapes, escape-channels, and tanks where it is not convenient to turn escape water into natural draining channels; and lastly by the introduction of the contract system, which is so strongly advocated on other important grounds, I feel quite sure that after a canal has had a few seasons' trial, and the distributing works and escapes have been even tolerably well arranged, that there need be no wastage of water nor unnecessary flooding of lands. It is only necessary that the water should have a sufficient price placed upon it (I believe the rate charged in the Punjab is extremely small), and that in fixing the size of the orifices for measurement, care should be taken not to give each village or cultivator too much water. Any carelessness in the management of the water may be visited by a moderate fine, to be inflicted by the regular revenue establishment on sanitary grounds.

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* So great is the advantage of the natural flow irrigation to the cultivator, that in Khandeish the people actually excavate and lower the level of the fields at great expense to get the water to flow on to them rather than go to the expense of raising the water continually. These cases are of course not numerous, as the works are always designed for natural flow irrigation, and it is only land for additional irrigation that is thus lowered in level.

13. The question of establishments is one on which I express an opinion with diffidence, as on this side of India we have not much experience, and hitherto the practice has been to keep the two duties of canal management and the collection of canal revenue quite distinct. The Public Works officers have nothing whatever to do with the canal revenue, and considering how much there is for the engineer to attend to, and how well the duty of assessing and collecting revenue is understood by the regular revenue establishments, the present arrangement seems to me to be the best one. The canal officers, however, should be furnished punctually with the most complete information respecting cultivated areas, both irrigated and unirrigated, in the district through which the canals pass, as it is most essential to the proper designing and management of the works that the canal officers should possess a sound knowledge of revenue matters.

14. The advantage of having the irrigated lands surveyed and the field boundaries distinctly and finally laid down is explained in the papers under reference. In the Deccan also this subject has received consideration, and this would seem to be a proper place for briefly alluding to a proposal made by Captain Elphinstone, lately Superintendent of Revenue Survey in Khandeish, for the survey and assessment of irrigated lands in that province, where, though the rate is by no means too high for irrigated lands, it falls very unequally on the cultivators, the man irrigating an acre of wheat paying as much as the man irrigating an acre sugarcane, though the quantity of water required for the sugarcane is at least twelve times as great as that required for the wheat, and being a perennial supply, it is infinitely more costly to Government to maintain. The profit to the cultivator from the sugarcane is, moreover, not less than ten times that derived from the wheat or other dry crop. The object of Captain Elphinstone's proposal was an equitable adjustment of the assessment. The object of the survey recommended for the irrigated lands in the Punjab is the saving of trouble and expense and many other

evils attendant on the frequent measurement of the irrigated areas. But either of the surveys proposed will, if carried out, provide, I think, against all the difficulties mentioned. Captain Elphinstone's proposal was to divide the land into moderate-sized plots, and to fix three rates of assessment for each plot, according to the nature of the crop irrigted, the rates being proportional to the quality and value of the water required for each crop. Thus a plot No. 30 containing one acre would be assessed at say Rs. 18 if under sugarcane, Rs. 9 if under rice, plantains, &c., and Rs. 4 if under wheat, Indian corn, pepper, or other light dry-crop. The cultivator was to be furnished with a deed and tabular statement showing the assessment that would be imposed on each plot under the three different classes of crop. Field boundaries were of course not to be altered. This arrangement would preclude the necessity for constant measurement of areas, and the cultivator too would know always what he had to pay; and be as secure as any arrangement could make him from oppression or harrassing interference. This system it is believed by the Irrigation officers would work well in the Deccan on the ordinary small irrigation channels, where it is almost impossible for the people to waste water owing to the steepness of the country, which causes any waste water to at once pass on to works further down the stream. For any wilful waste provision already exists in the Penal Code.

15. Captain Elphintone's object was to introduce one equitable assessment, and prevent the whole of the irrigation falling into the hands of a few rich men, who, cultivating large areas of sugarcane at enormous profit, could afford to irrigate inferior crops at little or no profit, merely to retain possession of the land and prevent the poorer people from getting hold of it and claiming a share of the perennial water and cultivating sugarcane. But I should mention that the Irrigation officers perceive another advantage that such a system would secure, which is the preventing of uncontrolled extension of irrigation by people on the higher part of a stream to the great injury of those lower down.

The extension is certain to take place under the ordinary settlement system, whereas on the old Deccan works it is a matter of difficulty, amounting practically to an impossibility, to give the water out by measurement, owing to the scattered nature of the works and their imperfections of construction. The arrangement proposed by Captain Elphinstone would enable the Revenue department, advised by the Irrigation officers, to control the extension of irrigation in the higher parts of the streams. It would be easy after such a survey had once been made to inform each cultivator that his areas of sugarcane and other crops for which there might be a scarcity of water were not to exceed a certain limit each year.

16. In the case of large new works of good construction, the survey assessment would only be the intermediate step before introducing the contract system, which, where practicable, is universally regarded as the best. After the people have learnt how to use the water, and have seen from a few years' actual experience how much land can be irrigated by their channels, the use of the water may be sold to them for a fixed period; perhaps for the first sale five years would be sufficient, as during that time the people would learn the utmost limit to which their irrigation could be extended, and then a much longer lease at an enhanced charge would be both feasible and fair.

17. The contract system would, if judiciously applied, entirely prevent wastage of water, and it will attain one all-important end very clearly set forth in the Punjab papers, viz. the securing of the utmost possible effect from a given quantity of water. I believe that it is not at all essential that the apparata for measuring the water should be accurate, and that if the measurement is only approximately correct, simple in arrangement, and not liable to any alteration at the hands of any one, it will give satisfaction; and by not giving too much water to each village or cultivator, a maximum effect will be obtained from a canal's supply. In considering the subject of measuring water with great accuracy,

it should not be forgotten that even with the measuring tank system, which though very costly, and in some respects, I think, objectionable, would undoubtedly measure the water with greater accuracy, there is still as wide room as ever for great variation of the annual or season's supply in the canal. The rain-fall of the season and the general condition of the canal works must materially affect the supply of most large canals each year, and I think therefore that as we cannot ensure the same quantity of water to each cultivator for two consecutive seasons, we might well rest contented with a rougher system for measuring the water and giving to each cultivator his proportional share of the whole supply. This I believe may be attained with sufficient accuracy by the use of simple apparata and by good management on the part of the canal officers, who, by means of gauges carefully registered in every part of the canal and its branches, and by personal observation, will closely watch the condition of the works. For any variation that may take place in the supply of water, either owing to the variation in the rain-fall, ordinary accident to the works, or inaccuracy in the working of the measuring apparata, the people must take their chance just as they do, but to a far greater degree, in cultivating the ordinary rain crop, the value of which may vary from almost nothing to a handsome profit, according to the rain fall during its growth and the state of the market when it is ripe.

I have the honour to be, &c.

J. G. FIFE, Lieut. Colonel,
Superintending Engineer for Irrigation.

No. 468 of 1864.

True copy forwarded to the Revenue Commissioner Southern Division.

J. G. FIFE, Lieut. Colonel,
Superintending Engineer for Irrigation.

Camp Bhagoor, Nassick, 29th March 1864.

No. 1272 of 1864.

Camp Sattara Districts, 7th April 1864.

Forwarded to the Superintendent of Revenue Survey Southern Maratha Country for perusal, and for any observations he may wish to make with reference to the Revenue Commissioner's endorsement No. 792, dated the 29th February last.

W. HART,
Revenue Commissioner S. D.

No. 184 of 1864.

From Major W. C. ANDERSON,
Superintendent Revenue Survey S. M. C.,

To W. HART, Esq.,
Revenue Commissioner S. D.

Superintendent's Office, 14th May 1864.

Sir,—I have the honour to acknowledge receipt of the papers forwarded with your endorsements (herewith returned) No. 792 of the 29th February last, relating to irrigation in the Punjab, and No. 1272 of the 7th ultimo, being a report made by Lieutenant Colonel Fife on the above Punjab irrigation discussion.

2. To obviate the difficulties met with in the satisfactory delivery of water by measurement of the natural flow, it is proposed by Mr. McLeod "that the distributing channels should carry the water below the surface, so that it should not in any case be delivered on the fields by natural flow but in all cases require to be raised." It is in fact proposed to form a trap or measure for the water in the shape of a reservoir of known area,

placed between the channel of natural flow and the land to be irrigated, but below the level of the latter, to which it could only be applied by means of some machinery and labour.

3. The above plan would entail on the ryot an expenditure of labour which must most materially reduce what he could afford to pay for water; his labour would be diverted from the various agricultural operations connected with the ploughing, manuring, &c. of his land, and preparing it to receive the water obtained by natural flow to raising the water itself. The proposed plan it appears to me would be economically justifiable only in the case of labour being in excessive abundance and the supply of water exceedingly limited, the very opposite to these conditions exist on this side of India at any rate; the available supply of labour is quite insufficient for the ordinary demands of the country, irrigation is far less prevalent than is desirable, not because water is scarce, but because the artificial works for turning the natural supply to account do not exist; these once created in any locality, the deficiency, as far as that special locality is concerned, will for some time to come be turned into a surplus. I say for some time to come because much less labour and time will be required to construct a main irrigation work than to prepare all the land capable of being irrigated by it for the reception of the water. All the available labour will naturally turn itself to the land; it would be a most unfruitful policy, both as regards the production of the country and the revenue returns from irrigation works, to compel the diversion of a material portion of this available labour from the land to the water by the creation of difficulties, and requiring that to be done by art which nature would do for nothing if left to itself.

4. A considerable additional charge per acre irrigated, to meet the waste of water supplied by natural flow, would in my opinion be in every way more expedient than the proposed plan of a labour tax, and that a very heavy one payable in kind.

5. Colonel Fife proposes the adoption of a simple measuring apparatus, and that water be charged for according to the quantity supplied. In theory this plan appears to be quite free from objection, but the practical difficulties in the way of its introduction in this country would, I fear, prove very great for the following reasons :—

1*st.*—The use of the module does not appear to have succeeded as yet any where in India.

2*nd.*—It is perfectly new to the people ; they are distrustful of all innovations, even when the advantage to themselves is not very unapparent. It would require a very considerable amount of reasoning before a ryot could be got to understand that his supply of water measured in this manner had not been tampered with.

3*rd.*—The use of the module presumes, I imagine, simple payment for water supplied by volume, without reference to what is done with the water or to what land it is applied. On this side of India it is not the practice to charge at the same rate for water supplied to good and to bad land; the scale is graduated ; for instance land of a quality capable of growing sugarcane is assessed additionally, on account of water, at a much higher rate than land which with the same amount of labour and expense bestowed on it would, with the same supply of water, give but an inferior crop. It is, I imagine, not the custom of the country to look upon the land assessment and the water rater as two separate items, but to view the two together as the assessment of irrigated land which must vary in proportion to its productive qualities just as much as that of dry-crop land.

6. But there would be no difficulty in varying the charge for the quantity of water supplied by module in some proportion to the quality of the land to which it was to be applied ; this could

be easily arranged. Experience only can show whether the other difficulties can be overcome. If they can, the great difficulty of the mode of assessing water rate in lands supplied by new works of irrigation will be overcome. Though by no means sanguine regarding the result being more satisfactory on this side of India than it appears to have been elsewhere, the use of measuring apparatus, as advocated by Colonel Fife, is certainly worth trying, if only for the satisfaction of those who advocate their adoption.

7. I believe that the most feasible plan and the most convenient for practical use will be found in a modification of that in ordinary use among the people of this country. In native states and in our districts under former rule some description of crop assessment will be found to be, or to have been in use. In most cases the assessment of irrigated land, that is the land rate and the water rate conjointly, will be found to have varied annually with the crop grown in each year, there being one rate on a given area of one crop and a different rate on another. In some cases the irrigated land bore a fixed unfluctuating assessment without reference to the crop grown in any particular year, but supposed to be in proportion to the general average of crops ordinarily grown on that land, that is to the productive powers of the land and water combined.

8. Under the survey revision of assessment we ascertain in each revenue survey field, if it does not amount to an entire revenue survey field, the area which is actually irrigated, and then fix the assessment on that area by scales differently framed for districts of different capabilities, but in which the quality of the soil and the mouth to which water is available always combine to give the rate per acre. This assessment is then permanent and liable to no modification, except in case of any very decided alteration in the supply of water, such as would for instance occur by the bursting and non-repair of a tank—cases in fact which in my experience are of the rarest possible occurrence.

9. I see no difficulty in modifying the above plan so as to adapt it to the requirements of land irrigated from new works. To this end it would, even where the revenue survey had been already completed, be necessary to resurvey the lands to be irrigated. Probably having been dry-crop land hitherto, the lands susceptible of irrigation by the new work would be found to have been made into revenue survey fields of greater area than would be convenient for irrrgated land, in which holdings always run so much smaller than in dry-crop land. I would therefore subdivide all the lands susceptible of irrigation into revenue survey fields of from two to five acres, according to circumstances.

10. The water rate per acre in addition to the soil or dry-crop assessment should then be fixed in some proportion to the quality of the soil and with regard to the mouth to which the water would on an average of years run. The ryot should then be permitted to have water supplied at intervals of a certain number of days in sufficient quantity to water the whole revenue survey field for the average of the crops it was capable of producing. If a watercourse for instance would run in the general average of years till the beginning of May, sugarcane could be grown in one-third of each revenue survey field in triennial rotation, and the ryot should be entitled to have water for the whole field in ten or fourteen days' rotation. In the land on which, in consequence of its not being the rotation year, sugarcane could not be grown; other crops would be grown till nearly if not quite up to the month of May; if those other crops were not grown and all the water to which the ryot had a right was not required by him, he would probably have no difficulty in selling it to some of his neighbours who might require it.

11. I would not permit any ryot to have water for part of a revenue survey field. He should pay the water rate in the entire field, or take no water. Neither would I allow him to take water one year and give it up the next. In the first instance it might be advisable to allow the water to be taken on trial free for one

year. After that a three or four year period should be required, after which the period might be extended to a still longer term.

12. The above plan entirely obviates any annual inspection of the newly-irrigated land; it would only be necessary to see that water was not stolen and applied to land which had no right to receive it. No crop inspection would be required. The water revenue would be collected with the land revenue by the ordinary village establishment in the same manner as the ordinary land revenue, as is the case in all our water revenue derived from old works. A ryot would take up water as he takes up land, with the sole difference that he would be allowed one year of trial free before entering into any more protracted engagement. It may be said that it would be hard to bind the ryot, except from year to year, but in practice we find no hesitation on the part of the people to take water from new or improved works, apply it to dry-crop land, and pay the additional assessment for irrigated land, and to bind themselves so far that so long as the supply of water is forthcoming they must pay for it whether they use it or not, and can only obtain exemption by resigning the land entirely, which in reason no one would do unless the assessment is excessive; for if the land is valuable as dry crop, its value is greatly enhanced by the addition of a supply of water, enhanced far beyond the additional charge for that water so long as the charge is a reasonable one. A high water rate will defeat any scheme, and interdict the use of water just as much as a high land assessment will keep land waste.

13. The following table is a specimen of the kind which I propose for extracting the assessment of irrigated land, that is the assessment due to soil and water together; it is in fact a specimen of the kind of table which is in daily use in the Southern Maratha Country survey for this purpose. Of course in practice more gradations of quality of soil and mouth of water are necessary, and the proportional rates are subject to modification. Sixteen annas

classification value represents the very best soil; ten annas a medium quality, requiring more labour and manure than the best, but yet capable of producing every kind of crop, though in an inferior degree to the best; four annas represents poor soil which would never be used for sugarcane or other superior crops; worse than this quality is in fact rarely found irrigated. We may suppose that the dry-crop assessment is fixed on a maximum rate of Rs. 2-8; that is that dry-crop land classed at a technical value of 16 annas per acre will bear Rs. 2-8 per acre, and so downwards in like proportion :—

Classification Value.	Assessment of Dry Crop.	Month to end of which Water is supplied by natural flow.			
		May.	February.	December.	October.
		Assessment.	Assessment.	Assessment.	Assessment.
	Rs. a.	Rs. a.	Rs.	Rs. a.	Rs. a.
16	2 8	7 8	5	4 0	3 4
10	1 9	5 8	3	2 8	2 0
4	0 10	3 0	2	1 8	1 4

14. The sum under the month represents the entire assessment of the land due to soil and water conjointly. The second column shows what would have been the assessment of the same land if not irrigated. The months of May, February, December, and October are taken in reference to the Deccan or Southern Maratha Country average climate, under which a heavy fall of rain may be certainly looked for before June, and an artificial supply to the end of May is the utmost which can be required; in fact in the Southern Maratha Country a good artificial supply up to the middle

of April will carry sugarcane through if enough water remains to give one slight watering; after that more cannot be desired. Water which is only availabe to the end of October will do little more than secure the ordinary dry crop from damage from drought in the monsoon. In the very good soils, which are very retentive of water, it may enable an after-crop of some kind to be raised after the early crop or that sown in June has been reaped.

15. The method of arranging the distribution of the water in proper rotation is the only point remaining unnoticed. In the Southern Maratha Country and Sattara we find the people generally settle this among themselves. Irrigation is very extensive from tanks and watercourses from streams, yet the disputes are not so numerous as to induce a belief that the people are not capable of managing the matter among themselves with reasonable fairness. In some few places in the Southern Maratha Country, and more frequently in Mysore, there is a village servant whose business it is to see to the proper distribution of the water; he is paid by a certain allowance of grain from each person to whom he distributes water, and also by a grant of land or of cash from the State. In the case of new works, in the first instance, it might be necessary to supervise the distribution through a Government servant, but as soon as the irrigated area approached its probable maximum, it would be advisable to endeavour to surrender the management into the hands of the villagers. A village servant to superintend the distribution might or might not be appointed as appeared expedient.

I have the honour to be, &c.

W. C. ANDERSON,

Supt. Revenue Survey and Assessment S. M. C.

No. 302.

From Major J. T. FRANCIS,
Supt. Revenue Survey and Assessment,
Tanna and Rutnagherry,

To. W. HART, Esq.,
Revenue Commissioner S. D.

Camp Khandalla, 3rd May 1864.

SIR,—In returning the correspondence marginally noted on the subject of the measurement of water and general management of canals in the North-West Provinces, I have the honour to offer the following remarks on the important questions discussed in these papers.

1. Revenue Commissioner's endorsement No. 792 of 29th February 1864, and the Government Resolution No. 662, dated 24th idem and its accompaniments.
2. Do. No. 1272 of 7th April 1864, and Lieutenant Colonel Fife's memorandum, No. 468 of 29th March 1864, and its accompaniments.
3. Major Anderson's letter, No. 184, dated the 14th May 1864.

2. It is to be regretted that the attempt to introduce a system for the regular measurement of canal water for irrigation should have been unsuccessful. That they have failed seems to be clearly shown in the discussion on this subject, and it is now proposed to supplant that system, either by the construction of tanks to be used as reservoirs for the stowage of canal water, or by the construction of underground distributing channels, from which the water is to be raised by machinery, and no irrigation by natural flow permitted.

3. The first plan, as Colonel Fife has explained, would not be applicable to the Deccan, owing to the surface of the country being very undulating, which would preclude the irrigation of large areas from a single reservoir, and the construction of numerous reservoirs would make the plan too expensive for general use. It is doubtful too whether such a plan would not be too expensive in any case,

and such seems to be the opinion of some of the experienced officers who have recorded their opinion upon the subject.

4. With regard to the other suggested plan of constructing covered distribution channels, from which the water is to be raised by machinery, the advantages which this system would command, considered in the most favourable light, seem to me to be of little importance when compared with the advantages to be foregone by the rejection of the simple and inexpensive process of obtaining water by natural overflow. The objections to the latter system appear, moreover, to be attributable to defects of management rather than to defects in the system itself, and I should think that it would be more expedient to endeavour to remedy them rather than to substitute the novel, expensive, and seemingly intricate system involved in the use of underground channels.

5. As however the plan of measuring water, whether obtained by natural overflow or raised by machinery, seems to be attended with considerable difficulties, it has been suggested that the plan of fixing the water rate on the area of the land irrigated should be adopted. This is the system in use in all the districts of our presideney, including Sind. Our irrigational works, excepting perhaps some in Sind, are miniature concerns when compared with the important works of the North-West to which this correspondence relates. Nevertheless the plan which has been found to work well on a small scale, might perhaps with some modifications be adapted to the large field of irrigation here referred to.

6. Our first step in the process of fixing a water rate (which has been described by Major Anderson) is a minute measurement of all the area irrigated, or capable of irrigation, from any work. The lands are divided into small-sized fields varying from three to five or six acres in extent. The boundaries of these fields are carefully defined with boundary-marks (cut stones generally), and their position accurately defined in the village maps. Under this system of operations the field can always be identified, and when

once regularly surveyed no further measurement is required, an inspection of the boundaries with the aid of the map being the only measure necessary to ensure the maintenance of the survey of irrigated lands.

7. The measurement being completed in this way, the lands are next classified, when a full and precise record is made of all the circumstances connected with the water supply. The information is usually embodied under the following heads:—

1*st.*—The nature of the supply, whether perennial or for part of the season only; if the latter, the months to which it usually lasts.

2*nd.*—The nature of the crops grown.

3*rd.*—The share of the water belonging to each holder of land.

4*th.*—The rotation period under which the distribution is made to each field.

5*th.*—The distance of the field from the distribution channel.

6*th.*—Whether any expense attends the enjoyment of the water, such as the maintenance of a private channel.

8. With this information before him the Superintendent of Survey or Settlement Officer proceeds to fix the value of the water supply in the manner explained in paragraph 13 of Major Anderson's letter.

9. "Some of our irrigational officers, amongst them Colonel Fife, and some of the survey officers too, are of opinion that a crop rate system of assessment would be better adapted to the irrigation of this presidency than the plan explained above. They argue that under the fixed rate system a man pays the same for a sugarcane crop as he would do for a wheat or grain crop, whereas the former requires eight or ten times the quantity of water that would suffice for the latter. But this objection to the fixed rate system is obviated by the plan on which the assessment

is fixed. The Superintendent, for instance, when fixing his rates knows from the information before him that the water supply is sufficient for a sugarcane crop. His experience tells him that this is a crop which can be cultivated only once in three years, and that in the intermediate years light crops are grown, requiring less water. If therefore we suppose a field to contain six acres, a third would be annually under sugarcane cultivation and the other two-thirds under light crops, wheat, gram, &c. If therefore the rate be fixed on the average of the three years' estimated supply of water for the several crops, the payment will be the same for the three years as it would be under the annual crop rating system, except that in the latter case a fluctuating rate would be levied for each year in place of the average fixed as above.

10. The crop rate system is well adapted for new irrigational work where the cultivation is fluctuating. But when the limits of the irrigable land have been defined, and the ryots become accustomed to irrigated cultivation, I think the fixed is preferable to the crop rate system of assessment, more particularly as it dispenses with the objectionable plan of an annual measurement and inspection of crops unavoidable in the latter case.

11. It may appear perhaps from Major Anderson's description of our system of fixing the assessment that the land and water rate are not kept separate. The two assessments are shown in one sum in some districts, but in the parts of the presidency in which I have been principally employed the water rate is kept quite distinct from the land assessment, and is so shown in the accounts. But this difference in the way of exhibiting the assessment is immaterial as the result is the same under both systems. The 7 rupee rate for instance, given in the statement in paragraph 14 of his letter, is made up of a land assessment of $2\frac{1}{2}$ per acre and a water rate of 5. The two sums would be shown separately in this way in the papers prepared under the system adopted by me. The two would be combined in one sum in the other; case but by deducting the land assessment we arrive at the rate fixed specially for the water supply.

12. The collection of the land and water assessment is made by the regular revenue establishment, being part of their ordinary duties. It is a great advantage to have a system susceptible of management in this manner; for besides the saving of expense connected with the entertainment of establishments for annual measurement and inspection duties which the North-West system entails, the ryots are freed from the harass and annoyance of being constantly called away from their fields to attend on Government officials when in the performance of the above duties.

13. But the great difficulty involved in the fixing of a water rate is that of apportioning the supply of water to the different fields. On our side, however, this difficulty has not hitherto been met with; for in all our old irrigational works we have found that the ryots had arranged this amongst themselves, generally by roughly allowing a certain time for the use of the water to the several fields or holders thereof according to their recognised rights. There is usually a man appointed to the duty of supervising the distribution, and it is surprising how well the plan works, for suits for water rights are almost unknown on our side. But where no such agency or system exists it will be necessary to entertain a regular establishment for this important duty; for it is obvious that no water assessment by measured areas would be fair unless it were contingent on the use of a defined supply of water. But with a regular establishment entertained purposely for supervising the distribution of water, as is proposed in these papers, there would seem to be one great difficulty in introducing in the North-West the system of charging a water rate on the irrigated area on the plan adopted in our presidency.

I have the honour to be, &c.

J. T. FRANCIS, Major,
Supt. Revenue Survey and Assessment,
Tanna and Rutnagherry.

No. 3786 OF 1864.

REVENUE DEPARTMENT.

From the REVENUE COMMISSIONER S. D.,

To the SECRETARY to GOVERNMENT, Bombay.

Poona, 21st September 1864.

SIR,—In obedience to the instructions contained in Government order No. 662, dated 24th February 1864, I have the honour to submit the following observations on the subject of the papers forwarded to me along with it.

2. These papers were referred by me to Colonel Fife, Superintending Engineer for Irrigation, and to Majors Anderson and Francis, Superintendents of Revenue Survey, whose replies are annexed to this letter.

3. The main points for consideration appear to be—

1*st*.—The assessment of the water rate.

2*nd*.—The mode in which the water should be distributed.

3*rd*.—The agency to be employed in collecting the rates.

4. With respect to the assessment of the water rate, the first point to be ascertained is of course the precise area susceptible of being irrigated, which will necessitate an accurate survey. The land comprising this area should then, I think, be assessed as baghayet, as is now done in cases where the supply of water for irrigation has existed from of old, with this important difference however, that where Government have created the supply by artificial means, involving a large outlay of public money, they should be entitled to look for a far higher revenue than where, as has for the most part been the case with respect to lands subjected to baghayet rates hitherto, they have found the supply ready to hand. The

two principal points to look to in fixing such an assessment as regards its amount will be the period during which the water will be available and the nature of the soil to be irrigated. When the amount is fixed the ryot should be allowed to cultivate whatever kind of crop he may prefer. I confess I should view with much distrust any attempt to base any system of irrigational revenue on a "jinuswar" or crop assessment. Any annual inspection of crops for this purpose would not fail to give rise to fraud and to vexatious official interference. In order to satisfy the ryots in places where garden cultivation has hitherto been unknown that they could really make a good profit by it after payment of the enhanced (baghayet) rates, the levy of the fixed rate (which should, however, be at once declared) might, if necessary, be postponed for one or even two years, the ryot being allowed meanwhile to cultivate free of water rate.

5. With respect to the mode in which the water should be distributed, it has been proposed in the Punjab that the distribution should be made by means of channels below the surface, and not by the flow of the water in surface channels. This plan appears to have been advocated in the Punjab mainly on sanitary grounds. In our districts, however, there is little fear of the health of the country being affected by inundation from irrigational canals. The only advantages which the sub-surface channels would possess in our districts would be the greater certainty of regulating the supply, and this would certainly be more than counterbalanced by the great extra expense occasioned by our not only declining to take advantage of the assistance of nature, but going out of the way to create a necessity for extra labour in a country where labour is already so expensive.

6. Lieutenant Colonel Fife has described two plans which he proposes to adopt in order to regulate the supply of water. It might be well to give them a trial. But for my own part I am doubtful as to the success of any arrangement based on the assumption that the volume of water delivered will be measured practically

with any degree of certainty. From what I can gather of the existing state of things in the Nassick districts and elsewhere, it is desirable to leave the regulation of the distribution as much as possible in the hands of the people themselves. The time system, by which a certain area of land is entitled to be flooded for a certain number of hours during the week or fortnight, is the plan with which the people seem most conversant. For the first two or three years after the construction of any great source of irrigational supply, it might be advisable to employ officials whose duty it should be to regulate the distribution according to this plan. In a very short time the people would readily fall into it.

7. Lastly, with regard to agency for collection of irrigational revenue, our existing revenue establishments would, under the system of baghayet assessment as above recommended, be sufficient for this work.

I have the honour to be, &c.

W. HART,

Revenue Commissioner S. D.

No. 3659 OF 1864.

REVENUE DEPARTMENT:

Bombay Castle, 27th September 1864.

Transferred to the Public Works Department for disposal, in continuation of the Government endorsement of this day's date, No. 3657.

H. E. JACOMB,

Officiating Under-Secretary.

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